

WHAT IS CLAIMED IS:

1 1. A transmit-receive type electric field proximity detector suitable for detecting
2 partially conductive or conductive objects regardless of their impedance to circuit ground,
3 said detector comprising:

4
5 a transmitting electrode;

6
7 a receiving electrode; and

8
9 at least one ground electrode,

10
11 arranged and sized such that, upon the approach of an object, a signal received by said
12 receiving electrode decreases, at least until said object is within a threshold distance of one
13 of said transmitting electrode, receiving electrode, and at least one ground electrode.

1 2. The proximity detector of claim 1, further comprising a signal generator electrically
2 coupled to the transmitting electrode.

1 3. The proximity detector of claim 2, wherein the signal generator is a low frequency
2 oscillator.

1 4. The proximity detector of claim 1, wherein one of the transmitting electrode and
2 receiving electrode is a generally circular disk of conductive material, and the other of the
3 transmitting electrode and receiving electrode is a generally circular annular ring of
4 conductive material, said transmitting and receiving electrodes being arranged
5 concentrically in substantially the same plane.

1 5. The proximity detector of claim 4, wherein said at least one ground electrode
2 comprises a first ground electrode being a generally circular annular ring of conductive

3 material interposed between, and lying in substantially in the same plane as, the transmitting
4 electrode and the receiving electrode.

1 6. The proximity detector of claim 5, wherein said at least one ground electrode further
2 comprises a second ground electrode being a plate of conductive material having an extent
3 at least equal to an extent of said other of said transmitting electrode and receiving
4 electrode, said second ground electrode being positioned behind, and substantially parallel
5 to, the transmitting electrode, receiving electrode, and first ground electrode.

1 7. The proximity detector of claim 6, wherein the first ground electrode is electrically
2 coupled to the second ground electrode.

1 8. The proximity detector of claim 7, wherein the first ground electrode and second
2 ground electrode are electrically insulated from said transmitting electrode and said
3 receiving electrode.

1 9. The proximity detector of claim 8, wherein said transmitting electrode is said
2 generally circular disk, and said receiving electrode is said surrounding generally circular
3 annular ring.

1 10. The proximity detector of claim 5, wherein a relative diameter of the electrode disk
2 is greater than 0 and less than 30, a relative inner diameter to outer diameter width of the
3 annular ring ground electrode is greater than 0 and less than 15, and a relative inner
4 diameter to outer diameter width of the outermost annular ring electrode is greater than 5
5 and less than 25.

1 11. The proximity detector of claim 8, further comprising detector circuitry coupled to
2 said receiving electrode and being responsive to the induced electrical signal therefrom for
3 generating an output signal indicative of the approach of an intruding object.

1 12. The proximity detector of claim 11, wherein said first ground electrode and said
2 second ground electrode are electrically coupled to circuit ground of said detector circuitry.

1 13. The proximity detector of claim 12, wherein said second ground electrode is
2 physically interposed between said detector circuitry and both the transmitting electrode and
3 the receiving electrode.

1 14. The proximity detector of claim 13, wherein said detector circuitry further comprises
2 a signal detector, an amplifier, and a rectifier, the input of said signal detector being
3 electrically coupled to said receiving electrode, the input of said amplifier being electrically
4 coupled to the output of said signal detector, and the input of said rectifier being electrically
5 coupled to the output of said amplifier.

1 15. The proximity detector of claim 1, wherein said threshold distance is about 10
2 millimeters.

1 16. A sensor suitable for use in a transmit-receive type electric field proximity detector,
2 said sensor having a circuit ground and comprising:

- 3
4 a transmitting electrode;
5
6 a receiving electrode; and
7
8 at least one circuit ground electrode,
9

10 arranged and sized such that, upon the approach of an object, the effective impedance
11 between the receiver electrode and the at least one circuit ground electrode decreases more
12 quickly than the sum of the impedance between the receiver electrode and the at least one
13 circuit ground electrode and the impedance between the transmitting electrode and the
14 receiving electrode, at least until said object is within a threshold distance of one of said
15 transmitting electrode, receiving electrode, and at least one ground electrode.

1 17. The sensor of claim 16, wherein one of the transmitting electrode and receiving
2 electrode is a generally circular disk of conductive material, and the other of the
3 transmitting electrode and receiving electrode is a generally circular annular ring of

4 conductive material, said transmitting and receiving electrodes being arranged
5 concentrically in substantially the same plane.

1 18. The sensor of claim 17, wherein said at least one ground electrode comprises a first
2 ground electrode being a generally circular annular ring of conductive material interposed
3 between, and lying in substantially in the same plane as, the transmitting electrode and the
4 receiving electrode.

1 19. The sensor of claim 18, wherein said at least one ground electrode further comprises
2 a second ground electrode being a plate of conductive material having an extent at least
3 equal to an extent of said other of said transmitting electrode and receiving electrode, said
4 second ground electrode being positioned behind, and substantially parallel to, the
5 transmitting electrode, receiving electrode, and first ground electrode.

1 20. The sensor of claim 19, wherein the first ground electrode is electrically coupled to
2 the second ground electrode.

1 21. The sensor of claim 20, wherein the first ground electrode and second ground
2 electrode are electrically insulated from said transmitting electrode and said receiving
3 electrode.

1 22. The sensor of claim 21, wherein said transmitting electrode is said generally circular
2 disk, and said receiving electrode is said surrounding generally circular annular ring.

1 23. The sensor of claim 18, wherein a relative diameter of the electrode disk is greater
2 than 0 and less than 30, a relative inner diameter to outer diameter width of the annular ring
3 ground electrode is greater than 0 and less than 15, and a relative inner diameter to outer
4 diameter width of the outermost annular ring electrode is greater than 0 and less than 25.

1 24. The proximity detector of claim 1, wherein one of the transmitting electrode and
2 receiving electrode is a first plate of conductive material having a first polygonal outline,
3 and the other of the transmitting electrode and receiving electrode is a second plate of
4 conductive material having a second polygonal outline, said second plate having a

5 concentric aperture, said aperture having a third polygonal outline, said transmitting and
6 receiving electrodes being arranged concentrically in substantially the same plane.

25. The proximity detector of claim 24, wherein said at least one ground electrode comprises a first ground electrode being a third plate of conductive material having a fourth polygonal outline, said third plate having a concentric aperture, said aperture having a fifth polygonal outline, said first ground electrode being interposed between, and lying in substantially in the same plane as, the transmitting electrode and the receiving electrode.

26. The proximity detector of claim 25, wherein said at least one ground electrode further comprises a second ground electrode being a fourth plate of conductive material having a sixth polygonal outline, said second ground electrode having an extent at least equal to an extent of said other of said transmitting electrode and receiving electrode, said second ground electrode further being positioned behind, and substantially parallel to, the transmitting electrode, receiving electrode, and first ground electrode.

1 27. The proximity detector of claim 26, wherein each of said first, second, third, fourth,
2 fifth and sixth polygonal outlines is a regular polygonal shape with sides of equal length.

1 28. The proximity detector of claim 27, wherein the first ground electrode is electrically
2 coupled to the second ground electrode.

1 29. The proximity detector of claim 28, wherein the first ground electrode and second
2 ground electrode are electrically insulated from said transmitting electrode and said
3 receiving electrode.

1 30. The proximity detector of claim 29, wherein said transmitting electrode is said first
2 plate, and said receiving electrode is said surrounding, apertured second plate.

1 31. A communications device comprising:

(c) a transmit-receive type electric field proximity detector suitable for detecting partially conductive or conductive objects regardless of their impedance to circuit ground, said detector comprising:

- a transmitting electrode;
- a receiving electrode; and
- at least one ground electrode,

arranged and sized such that, upon the approach of an object, the effective impedance between the receiver electrode and the at least one circuit ground electrode decreases more quickly than the sum of the impedance between the receiver electrode and the at least one circuit ground electrode and the impedance between the transmitting electrode and the receiving electrode, at least until said object is within a threshold distance of one of said transmitting electrode, receiving electrode, and at least one ground electrode,

said detector further comprising detector circuitry coupled to said receiving electrode and being responsive to the induced electrical signal therefrom for generating an output signal indicative of the approach of an intruding object; and

(d) a switch capable of switching between a receiver mode and a loudspeaker mode;

said output signal of said proximity detector being coupled to said switch to operate said communications device in loudspeaker mode when said device is separated by at least a predetermined threshold distance from a user's ear and in the receiver mode when said device is separated by less than said predetermined threshold distance from the user's ear.

32. A sensor suitable for use in a transmit-receive type electric field proximity detector, said sensor having a circuit ground and comprising:

- a transmitting electrode driven with a low impedance;

5
6 a receiving electrode actively held at circuit ground potential; and

7
8 at least one circuit ground electrode connected to an earth ground,

9
10 arranged and sized such that, upon the approach of an object, the capacitance between the
11 object and circuit ground increases more quickly than the product of the capacitance
12 between the object and the transmitting electrode and the capacitance between the object
13 and the receiving electrode, at least until said object is within a threshold distance of one of
14 said transmitting electrode, receiving electrode, and at least one ground electrode.